Claims

1. In a FIB column subassembly including an ion gun including a liquid metal ion source, a plurality of lens elements for extracting and focusing the ions, one or more beam apertures, and an electrostatic deflection means, the improvement comprising one or more dielectric bushings for positioning one or more lens elements and for providing a vacuum container for the one or more elements.

2. The FIB column of claim 1 in which the dielectric bushing positions and electrically isolates one or more components of an ion gun and in which the dielectric bushing forms a vacuum container for the ion gun.

3. The FIB column of claim 1 in which electrical wires penetrate at least one of the one or more ceramic bushings.

4. The FIB column of claim 3 in which the wires penetrating at least one or more ceramic bushings are vacuum sealed using a fusing process, a brazing process, a glue, or O-rings.

5. The FIB column of claim 1 in which the FIB column includes final lenses and in which the position of the emitter is fixed relative to the final lenses and further comprising electrostatic steering electrodes between the gun and final lenses.

6. The FIB column of claim 1 further comprising electroetched, electroformed, or laser ablated beam apertures.

7. The FIB column of claim 1 further comprising an in-vacuum isolation valve mechanism.

8. The FIB column of claim 7 in which the in-vacuum isolation valve includes a pneumatic bellows to activate the valve.

9. The FIB column of claim 7 in which the in-vacuum isolation valve includes a pushrod and bell crank to activate the valve.

10. The FIB column of claim 1 further comprising an in-vacuum aperture changing mechanism.

11. The FIB column of claim 10 in which the in-vacuum aperture changing mechanism comprises one or more piezoelectric actuators, DC motors or stepper motors for driving stage.

12. An ion gun for a focused ion beam system, comprising:

a dielectric housing;

an emitter assembly fastened to the dielectric housing, the emitter assembly including an emitter, a suppressor, an extractor and an extractor aperture; and

one or more ion optical elements fastened to the dielectric housing and aligned with the emitter assembly.

13. The ion gun of claim 12 in which the emitter assembly and the one or more optical elements are maintained in a vacuum and in which the dielectric housing provides the walls of a vacuum chamber.

14. The ion gun of claim 12 in which the dielectric housing is surrounded by a metallic shield.

15. The ion gun of claim 12 further comprising a vacuum isolation valve actuatable to seal the ion gun.

16. The ion gun of claim 12 in which the position of the emitter assembly can be adjusted to align the emitter assembly with the one or more ion optical elements fastened to the dielectric housing.

17. The ion gun of claim 12 in which the position of the emitter assembly is fixed in alignment relative to the one or more ion optical elements fastened to the dielectric housing.

18. A ion gun dielectric bushing comprising a dielectric material formed to support and align multiple ion optical elements and to form a vacuum chamber surrounding those elements, the vacuum chamber including at least one opening for supplying electrical voltage to one or more of the multiple optical elements.

19. A prealigned emitter assembly for a focused ion beam comprising an emitter, a suppressor, an extractor and at least one extractor aperture element, the emitter, suppressor, and extractor being positioned and aligned with respect to each other, the assembly capable of being inserted as a unit into an ion beam optical column.

20. The emitter assembly of claim 19 further comprising a dielectric housing for supporting the emitter, suppressor, and extractor.

21. The emitter assembly of claim 20 in which the dielectric housing includes a hole for passing an electrical conductor.

22. A focused ion beam column including:

a prealigned emitter assembly in accordance with claim 19; and

a mating member for supporting and positioning the emitter assembly.

23. A method of forming a gun assembly for a focused ion beam column, comprising:

providing a dielectric housing configured to support multiple gun elements and to form a vacuum container for the gun;

aligning metallic optical elements within the dielectric housing; and

providing electrical connections to the metallic optical elements through the one or more dielectric housings.

24. The method of claim 21 further comprising providing a vacuum pump for evacuating the vacuum container formed by the dielectric housing.

25. The method of claim 21 further comprising providing a vacuum isolation valve for isolating the dielectric housing.

26. In a multiple beam system for producing a focused ion beam column and a second charged particle beam within a system vacuum chamber, the focused ion beam column including a liquid metal ion source, a plurality of lens elements for extracting and focusing the ions, one or more beam apertures, an electrostatic deflection means, beam blanking means, and vacuum pump plus associated electronics and controls, the improvement comprising an ion gun dielectric bushing for supporting one or more gun elements and for providing a gun vacuum container for the one or more gun elements.

27. The method of claim 26 further comprising a vacuum isolation valve for isolating the gun vacuum container, the vacuum isolation valve actuation mechanism being operable without a mechanical drive connection to outside a system vacuum chamber.

28. The method of claim 27 in which the vacuum isolation valve is operated pneumatically and in which a pneumatic connection for operating the vacuum isolation valve passes through the wall of the system vacuum chamber.

29. The method of claim 26 further comprising an automated variable aperture drive positioned within the vacuum chamber, the drive being operable without a mechanical drive connection to outside the vacuum chamber.

30. The method of claim 29 in which the automated variable aperture drive includes a piezoelectric positioner.

31. The method of claim 29 in which the automated variable aperture drive includes an electric motor.